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TI - Method for preventing liquid leakage of zinc-air battery
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NOVELTY - The invention relates to a method for leak-proof liquid of zinc air battery. Resin layer with water absorbing capacity is set up on inside of battery container to totally absorb leaked liquid in the battery. Thus electrolyte will not leak to the outside of battery container. The invented method not only increases discharging current of battery, but also prevent electrical appliance, which uses battery, from damage caused by corrosion of leaked liquid.(Dwg.0/0)

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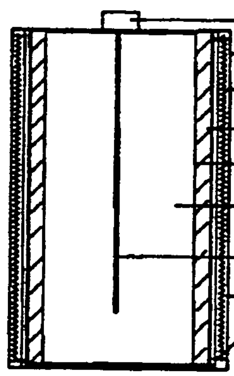
[54] METHOD FOR PREVENTING LIQUID LEAKAGE OF ZINC-AIR BATTERY

[57] Abstract

The invention relates to a method for preventing liquid leakage within the zinc-air battery. Resin layer with water absorbing capacity is setup inside of the battery container to totally absorb leaked liquid within the battery. Thus, the electrolyte will not leak to the outside of the battery container. The invented method not only increases discharging current of the battery, but also prevents the electrical appliance, which uses the battery, from damage caused by corrosion of leaked liquid.



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Claims

1. It is a method for prevention of liquid leakage of the zinc-air battery, which is characterized by the fact that a water absorbing resin layer is set up the inside of the battery casing.

2. It is a method for prevention of liquid leakage of the zinc-air battery as described in Claim 1, which is characterized by the fact the water absorbing resin layer is a porous layer.

3. It is a method for prevention of liquid leakage of the zinc-air battery as described in Claim 2, which is characterized by the fact that the stated porous layer is one or more than one of net-like, fiber-like, and foaming porous layers.

4. It is a method for prevention of liquid leakage of the zinc-air battery as described in Claim 1 or 2, which is characterized by the fact the stated water absorbing

resin is a starch or cellulose-modified water absorbing resin.

5. It is a method for prevention of liquid leakage of the zinc-air battery as described in Claim 1 or 2, which is characterized by the fact the stated water absorbing resin is a water absorbing resin of polyacrylic acids.

6. It is a method for prevention of liquid leakage of the zinc-air battery as described in Claim 1 or 2, which is characterized by the fact the stated water absorbing resin is a water absorbing resin of polyvinyl alcohols.

Description

A Method for Prevention of Liquid Leakage of the Zinc-air Battery

The present invention relates to the field of electrochemistry, particularly the method of liquid leakage of the zinc-air battery.

A zinc-air battery is a battery with zinc as the active substance for the negative terminal, while oxygen in air as the active substance for the positive terminal. After oxygen required by the battery is exhausted, it can be replenished continuously from air, to continue to generate current. Therefore, as long as there are sufficient materials present, i.e., zinc and electrolyte, for the negative terminal, the battery can last. Therefore, the significant characteristic of the stated battery is a high specific energy, which in theory can reach 1350 Wh/kg. For example, in the case of a common alkaline zinc-air battery, the reaction of the two terminals and battery is as follows:

Negative terminal	$Zn + 2OH^- \rightarrow ZnO + H_20+2e$
Positive terminal	$1/2O_2 + H_2O + 2e \rightarrow 2OH^-$
Battery reaction	$Zn + 1/2O_2 \rightarrow ZnO$

Because, in principle, the zinc-air battery depends on oxygen in the air to diffuse into the battery the entire battery system cannot be designed into a closed system. Normally the oxygen electrode or an oxygen electrode similar to that used in the fuel-cell battery mainly consists of three parts: the waterproof air permeable layer, the conductive net, and the catalytic layer. The waterproof air permeable layer is mainly made of a hydrophobic material, such as polytetrafluoroethylene, polyvinyl [compounds], etc. A large amount of capillaries are formed in it. When it contacts the electrolyte, because of the hydrophobic properties of the material, the liquid surface inside the capillary is shaped like a crescent moon, thus generating an additional pressure towards the inner part of the liquid. This pressure resists the permeation of the internal liquid, but the air

outside can go into the electrolyte in the battery through the capillary. The level of this pressure is related to the porosity of the micropores through which air diffuses into the electrode, to the contact angle of the dip of the electrolyte on the surface of the material on the inner side of the micropores, and to the steam pressure of the electrolyte, etc. , and is the key to the sealing of the battery.

As a matter of fact, for many years, the major reason that the zinc-air battery has not been largely commercialized is that some crucial technical problems such as alkali deposit and liquid leakage, and low current density for discharge, have not been well solved. As a result of the former, the electrolyte which leaks out during the use of the zinc-air battery to the outside of the casing will erode and damage the equipment that uses the battery; while as a result of the latter, the battery is applicable to electric equipment of smaller power, thus restricting the range of use of the battery. What is more, in between these two there is also a contradiction: in order to prevent alkali deposition and liquid leakage of the battery, an effective method would be to reduce the porous size of the micropores of the electrode for air diffusion and reduce the channel for air diffusion, that is, to reduce the general area of the micro pore, but as the same time, it would slow down the speed of diffusion of air into the battery thus reducing the discharge current of the battery. On the contrary, to enhance the discharge current of the zinc-air battery, an effective method would be to enlarge the porous size of the micropores for air to diffuse in the electrode, and enlarge the channel for air diffusion, that is, to enlarge the general area of the micropores, yet this would intensify alkali deposition and liquid leakage of the battery. This, by itself, is a defect in the principle of zinc-air battery. Only due to the stated reason, the heat of research for the zinc-air battery started in China and internationally in the 70s, gradually cooled down after the 80s. In recent years, with rapid development and update of portable electronic information products, there is an even higher requirement for the technical index of the battery, so that the research for a zinc-air that battery with a superhigh specific capacity begins to attract, once again, the attention of many researchers of chemical power resources at home and abroad. Researchers attempt to discover a solution from the aspects of the sealing structure of the battery, sealing materials of the battery, and an additional additive to the formula of the electrolyte, but up to the present time there has not been any fundamental breakthroughs.

The purpose of the present invention is—in view of the contradictions and defects present in the zinc-air battery mentioned above, and at the same time considering the use of the method of enhancing the current density of the battery discharge by means of enlarging the porous size of the micropores of air to diffuse in the electrode as well as the general area of the permeable pores—to make use of a method of prevention of liquid

leakage inside the battery, including the structural design and application of water absorbing resin materials, and to have the liquid leak of the battery absorbed entirely inside the battery, so that the electrolyte will not be leaked to the outside of the cell casing. In such a way, not only can the discharge current of the battery be greatly enhanced, but there is also a guarantee that there will not be any liquid leakage from the battery to erode and damage the appliances using the battery, thus effectively overcoming the contradictions and defects present in the zinc-air battery.

The present invention of the method of prevention of liquid leakage of the zinc-air battery is to set up a water absorbing resin layer in the inner side of the battery casing.

Figure 1 is a schematic diagram of the structure of the zinc-air battery with a water absorbing resin layer set up: After the electrolyte in the negative terminal 5, calamine cream, permeates out through the diaphragm tube 4 and the air diffused electrode 3, it will immediately be absorbed by the water absorbing resin layer 2 attached to the inner side of the battery casing 1, so that the electrolyte will not leak out from the air permeation pore 7 of the battery casing. The air diffused electrode 3 is linked with the external casing 1 of the battery through the terminal end 8, and the negative terminal 6 convection needle and the negative terminal cover 9 are connected into one piece.

The water absorbing resin layer used in the present invention may be a layer with a porous structure, such as a net-like, fiber-like, or foaming layer with a porous structure, and its thickness should be controlled in accordance with actual needs.

In addition to the rapid and high-performance absorption of water by the water absorbing resin material which is to be taken into consideration, its absorbing effect on electrolyte ions, and factors like changes in the volume after absorption of the liquid by the material, also need to be taken into consideration. Through many tests, the present inventors have found that starch or modified cellulose (such as graft acrylonitrile) water absorbing resins, water absorbing resins of polyacrylic acid, and water absorbing resin of polyvinyl alcohol (PVA) have the best results. This is mainly due to the fact that they all contain the water absorbing chain of a non-ionic polar group, and it can have the complex effect with the electrolyte ions in the solution, therefore it also has a good absorbing effect on the electrolyte solution.

In contrast with existing techniques, the present invention has the following advantages: (1) The liquid leakage is strictly controlled inside the battery, by means of absorption of the alkaline electrolyte leaked from the air diffused electrode using a water absorbing resin inside the zinc-air battery, so that the safety of the appliance using the battery will not be affected; (2) As the leakage prevention of the zinc-air battery and the porous size of the micropores for air permeation and the general area of the air

permeation pores in the air diffused electrolyte are not related at all, the discharge current of the battery can be enhanced using the method of random enhancement of the general area of the air permeation pores and enhancement of the porous size of the micropores for air permeation, thus fundamentally solving the contradiction and defect in the principle between elimination of alkali deposition and liquid leakage of the zinc-air battery and enhancement of the discharge current; (3) The stated invention is applicable to zinc-air batteries of various sizes and capacities, which are cylinder, square, and buckle in structure; (4) The present invention goes out from the traditional way of thinking of leakage prevention and technical routing in zinc-air battery technique, so that the problems of liquid leakage and alkali deposition and low discharge current which have been keeping the stated battery from utilization and commercialization have been solved, which will undoubtedly bring about a fundamental turning point for accomplishment of utilization and commercialization of the zinc-air battery.

Figure 1 is a schematic diagram of the structure of the zinc-air battery set up with the water absorbing resin layer in accordance with the present method.

The following is a further description of the present invention in association with examples and attached drawing.

Example 1:

--To prepare the air diffused electrode of the zinc-air battery

First of all, the materials for the waterproof air permeable layer and the catalyst layer are placed separately on a large roll blending equipment for repeated rolling and pressing to be mixed homogeneously, and fiberized. The fiberized materials are then added to a small roll shaping equipment to be rolled and shaped, so that two cylindrical films are made. These two cylindrical films and the cylindrical convection net are sheathed together, then placed on a small roll shaping equipment to be rolled and pressed into a cylindrical air diffused electrode. In the stated air diffused electrode, from inside outward in sequence are the convection net layer, the waterproof air permeable layer, and the catalyst layer.

-- To prepare the zinc electrode, diaphragm, and battery casing

A paste-like calamine cream is used for the zinc electrode, the diaphragm material is polypropyl non-woven fabric film, and the battery casing is the same as the casing of a regular zinc-manganese battery, but a hole needs to be opened on its positive terminal as the hole for air permeation. Attached to the inner side of the battery casing, there is a net-

like graft acrylonitrile water absorbing resin.

-- Assembly of a sample battery

After the cylindrical air electrode is shaped, through welding with the terminal end it is connected with the positive cover of the battery. In its inner lining the diaphragm tube is sleeved over, then the diaphragm tube is filled with calamine cream and a negative convection needle is inserted, sleeved with the negative cover. Finally the battery casing is sealed and a zinc-air battery as shown in Figure 1 is obtained.

The specifications of an assembled AA zinc-air sample battery are: 14.0 mm in diameter, 49.5 mm high, and it discharges using a constant current of 100 mA. The open circuit voltage of the battery is 1.43 V, the average working voltage is 1.20 V, and the discharge capacity reaches 5600 mAh. This zinc-air battery shows no sign of liquid leakage and alkali deposition either in the process of discharge or after standing at ambient temperature for 3 months.

Example 2

-- To prepare the air diffused electrode for the zinc-air battery

The method of preparation is the same as in Example 1, but finally it is cut into a square terminal chip of 10 x 10 cm.

-- To prepare the zinc electrode, diaphragm, and the battery casing

A paste-like calamine cream is used for the zinc electrode, the diaphragm material is polypropyl non-woven fabric film, for the battery casing a porous plastic casing is used. Attached to the inner side of the battery casing there is a net-like graft acrylonitrile water absorbing resin.

-- Assembly of a sample battery

After the air electrode is shaped, through welding with the terminal end it is connected with the positive cover of the battery. In its inner lining the diaphragm tube is sleeved over to separate the positive terminal and the negative terminal of the battery. Finally the battery casing is sealed and a square zinc-air battery is obtained.

The specifications of an assembled square zinc-air sample battery are: 102 mm x 12 mm x 102 mm, and it discharges using a constant current of 300 mA. The open circuit voltage of the battery is 1.43 V, the average working voltage is 1.25 V, and the discharge capacity reaches 30 Ah and higher. This zinc-air battery shows no sign of liquid leakage

and alkali deposition either in the process of discharge or after standing for 3 months.

Drawing Attached to the Description

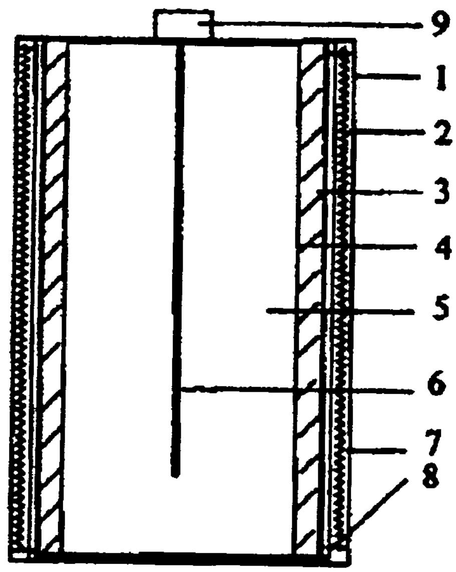

Figure 1

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